

# Evolution

## Origins of Life

- Inorganic molecules → organic molecules → self-replicating molecules (can reproduce)



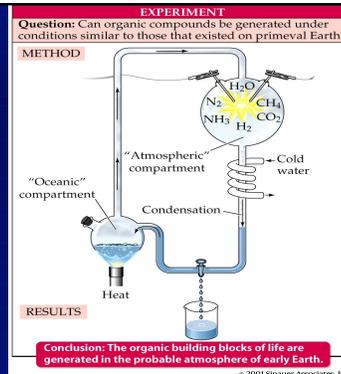
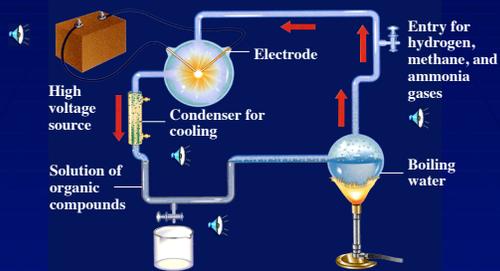
## Stanley Miller

- Designed test to see if early earth conditions could allow for the molecules needed for life to form
- Re-created early Earth's atmosphere with water vapor, ammonia, methane, hydrogen gas and lightning

- Found that **amino acids**, sugars, and small **organic compounds** (carbon) were formed
- Amino acids and organic compounds are some of the molecules that are found in living things

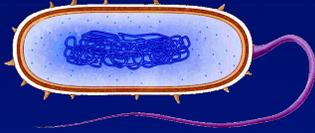
## The Origin of Life

### Simple organic molecules formed



## First form of life

- **Anaerobic prokaryotes (bacteria)**
- Anaerobic because there was no oxygen
  - Oxygen came from photosynthetic organisms
- Prokaryotic because prokaryotes are the simplest cells



## Abiogenesis

- Life that results from nonliving matter
- Refers to theories of how the first and simplest forms of life (prokaryotic cells) originated.
- Different from spontaneous generation that was disproved by Pasteur with broth

## Evolution of Cells

- The 1st cells were bacteria that were **anaerobic** (no oxygen remember).
- The 2nd type of bacteria to evolve were **chemosynthetic** (use chemicals in the ocean to get energy)
- 3rd, the **photosynthetic** bacteria developed
  - THEY PRODUCED OXYGEN
  - Changed the atmosphere greatly

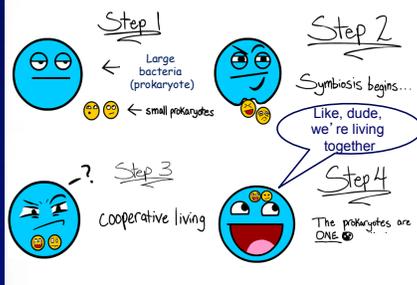
- This made it possible for **aerobic** respiration to evolve in bacteria- which is more efficient than anaerobic.
- Larger and more complex organisms now have the ability to evolve.

### Fourth, eukaryotic cells – Endosymbiosis

- Formed when two prokaryotic cells (bacteria) lived together.
- The smaller cells lived inside a larger prokaryote and benefited
- Smaller cells are thought to have evolved into chloroplasts and mitochondria.

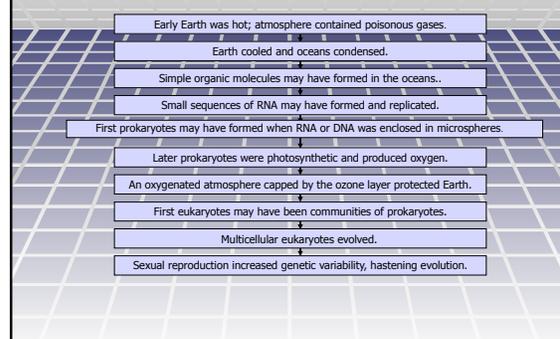
### Fifth event: Multicellular organisms

### The Endosymbiotic Theory



Next: The internal bacteria are PASSED ON from generation to generation. What this sound like?

### Evolution of Life

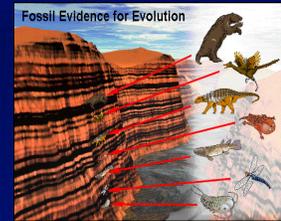


## Biogenesis

- Life results from existing life

## Fossils

- Remains of organisms from long ago
- Gives information about earlier forms of life on Earth
- Fossil layers on bottom are older than layers on top (if not disturbed)



## Relative dating

- If the rock layers have not been disturbed, the layers at the surface (on the top) must be younger than the deeper layers.

Which fossil is the oldest?



A



B



## Examples of Adaptations That Help Organisms Survive in the Environment

## Structural Adaptations

- Physical attributes
  - Looks like
  - Stings like
  - Bites like
  - Etc. like, whatever

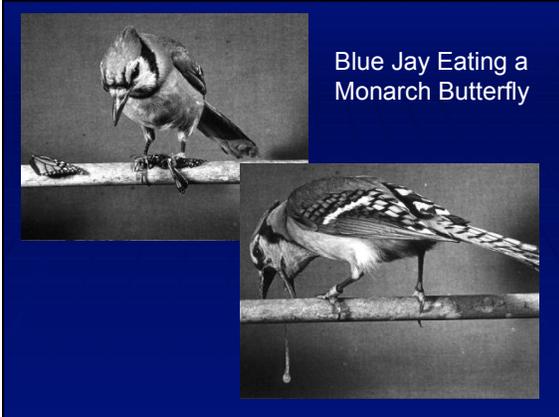
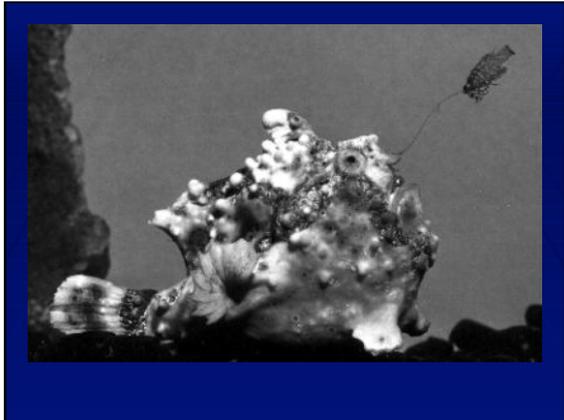
## Mimicry

- One species can look like another that is poisonous or bad tasting to predators
- Causes predator to avoid organism
- Organisms mimic predators, poisonous organisms or plants (autotrophs) to avoid being eaten

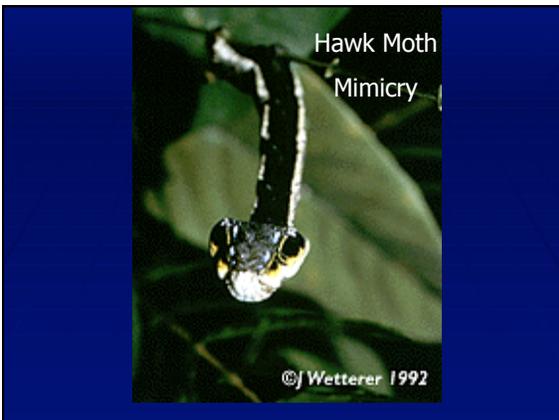
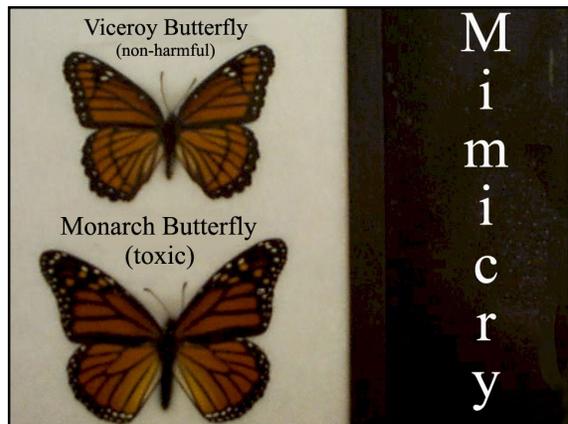


King Snake  
Nonpoisonous

Coral Snake  
Poisonous



Blue Jay Eating a  
Monarch Butterfly



## Camouflage

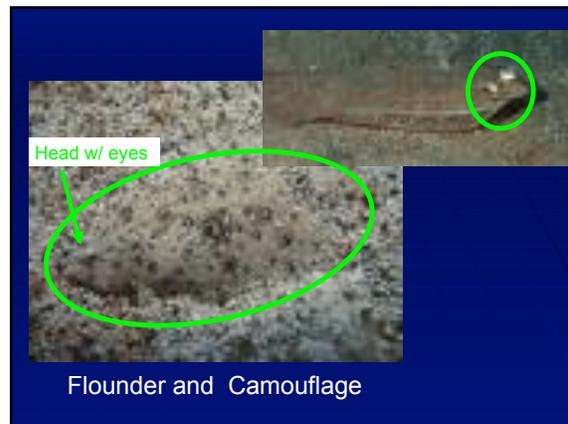
- Species blend in with their surroundings
- Blending in allows organism not to be seen by predator
- If not seen, it is not eaten



Camouflage



Camouflage



Flounder and Camouflage



## Physiological Adaptations

- Adaptations in the metabolic (chemical) processes

Examples are

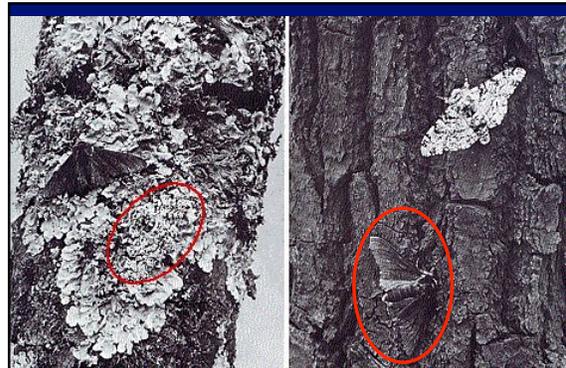
1. Bacteria are genetically resistant to penicillin
2. Insects and weeds are resistant to pesticides and herbicides.

The resistant organisms survive in their habitat and pass the resistance on to their children

## Natural Selection

- Organisms with certain traits have a better chance of surviving and reproducing
- Organisms that survive and reproduce pass their traits on to their offspring.
- Species change and become better adapted to their environment.

- Evolution by natural selection occurs.
- Examples:
  - British peppered moth
  - Populations of bacteria develop antibiotic resistance
  - Pesticide resistance in insects



Peppered Moth and Camouflage

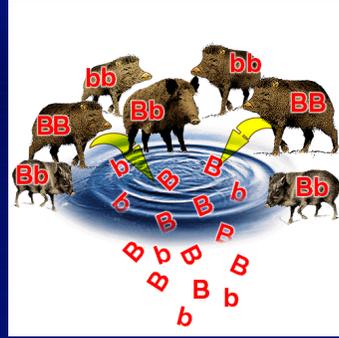
## Population Genetics and Evolution

### Population

- Members of same species
- Live in same area
- Able to reproduce fertile young

## Gene pool

- Genes in a population
- Collection for all genes of all traits
- Gene pool changes due to selection of traits



All of the genes in a population = Gene Pool

## Four Factors that Change the Gene Pool

### 1. Natural Selection

- Organisms that are well-adapted survive and pass on their genes to the next generation.
- Frequency of genes change from one generation to next

### 2. Mutation

- Adds a new gene type to gene pool
- May help or harm
- Mutation is helpful if organism is better able to survive in environment



- Example: effectiveness of antibiotics and pesticides decreases over time
- Mutations enable some bacteria or pests to survive and reproduce
- These mutations are passed on to offspring
- Offspring are not harmed and continue to reproduce (resistance is developed)

**Natural Selection and the Evidence for Evolution**  
**Physiological adaptations can develop rapidly**

The bacteria in a population vary in their ability to resist antibiotics.

When the population is exposed to an antibiotic, only the resistant bacteria survive.

The resistant bacteria live and produce more resistant bacteria.

**Evolutionary Arms Race: Disease**  
**REMEMBER—ALLELES MUST ALREADY BE PRESENT IN POPULATION**

- Bacterial resistance to antibiotics
  - MRSA
- Pesticides in various species
  - Insects (ORKIN)
  - Rodents
- Passive/active immunity
  - Passive Immunity: infant inherits mother's immunity; short term immunizations (injection of antibodies)
  - Active Immunity: bodies response to a live infection (either artificial—live vaccine or natural—school)
- Antivirals and vaccines
  - HIV strains resistant to retroviral medications

**3. Migration**

- Movement of members of a species into or out of a population
- Into – adds genes to pool
- Out of – removes genes from pool

**4. Isolation**

- Geographic isolation
  - Barrier between population divides it
    - Habitat fragmentation
  - Caused by rivers, mountains, human construction (buildings, roads)
  - Often results in **speciation**
    - development of a new species

- Reproductive isolation
  - Organisms can no longer mate
  - Caused by geographic isolation

**The Evolution of Species through Reproductive Isolation**

- The tree frogs are a single population living in the same area.

## The Evolution of Species through Reproductive Isolation



- The formation of a river may divide the frogs into two populations.
- This is called geographical isolation.
- The frogs can no longer mate with each other because they can't easily get across the river.

## The Evolution of Species through Reproductive Isolation



- Over time, the divided populations may become two species that may no longer interbreed, even if reunited.
- Populations can change due to mutations and natural selection.

KS3

10-20m tall

tentacles can detect light

Aliens have been spotted on Earth.

What can you conclude about its habitat on its home planet?

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KS4

**Alien 1**

Large size  
White skin with red stripes (no fur)  
Well developed molar teeth  
Sharp, bony tusks on face  
Ears very large in proportion to body.  
Large eyes on sides of head

**Alien 2**

Thick green fur  
Small size  
No ears – just holes in head for hearing.  
6 legs with well developed upper leg muscles  
Well developed canine teeth

Your task:

1. Draw an artists impression of the alien you are chosen to draw.
2. Use the information to describe:
  - The alien's habitat
  - The alien's feeding habits
  - Possible reasons for their features (how are they adapted?)
3. Make up one more adaptation for each alien – describing why it would have this feature.

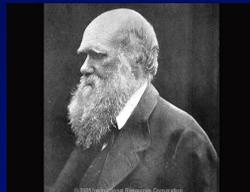
**Put this on the back of your drawing!**

**Put this on the back of your paper too!**

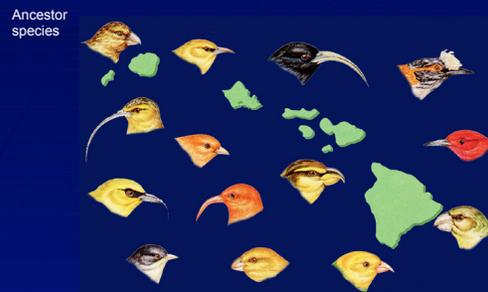
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## Charles Darwin

- Organisms change over time
- Changes are caused by natural selection



## Darwin's Finches



## FIVE STEPS of Darwin's Theory of Natural Selection

### Overproduction

- Before natural selection takes place, there must be an overproduction of species
- Species produce more organisms than can survive and reproduce
- They have the potential to increase in numbers exponentially



### 1. Variations

- Variations
  - differences among organisms
  - occur among the members of the same species
  - mutations are the primary source of variation
  - meiosis and sexual reproduction provide increased genetic variation
- Darwin was NOT able to explain variations in terms of cause: mutations, meiosis, and sexual reproduction (these were explained later)

### 2. Inheritance

- Individuals pass on traits to offspring
- Genotype determines phenotype
- Genes code for proteins!!!!
- Sexual reproduction increases genetic variation!
- Meiosis increases genetic variation
  - Crossing over
  - Independent assortment of chromosomes

### 3. Competition

- Organisms compete for limited resources
  - food, water, space to live, mates
- FINITE amount of resources



### 4. Survival of the Fit

- Some organisms have certain traits and are better adapted to their environment.
- These organisms have a much better chance of surviving and reproducing.
- Those without beneficial variations are less likely to survive and reproduce.
- CHANGING ENVIRONMENTS SELECT FOR SPECIFIC GENETIC PHENOTYPES

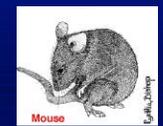


## 5. Change in Population

- Organisms with favorable variations
  - SURVIVE
  - REPRODUCE
  - PASS ON ALLELES TO OFFSPRING
- Accumulation and change of favored ALLELES leads to changes in species over time
- Could result in a new species
  - SPECIATION



Red-tailed hawk



Mouse



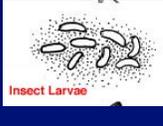
Cardinal



Seeds



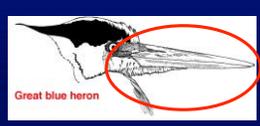
Pileated woodpecker



Insect Larvae

Retrieved from <http://www.dnr.state.nj.us/wildlife/kids/bbeaks.htm> on November 13, 2006.

### Variations in Bird Beaks



Great blue heron



Fish



Canvasback duck



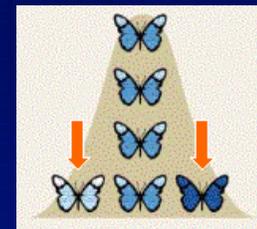
Water Plants



## Types of Natural Selection in Populations

### Stabilizing Selection

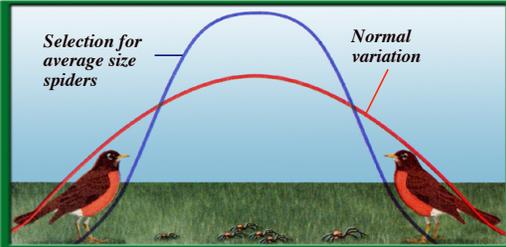
- Average individuals in population benefit
- Increases in middle of graph



**Mechanisms of Evolution**

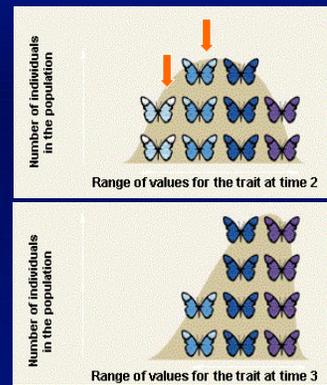
**Natural selection acts on variations**

- **Stabilizing selection** is a natural selection that favors average individuals in a population.



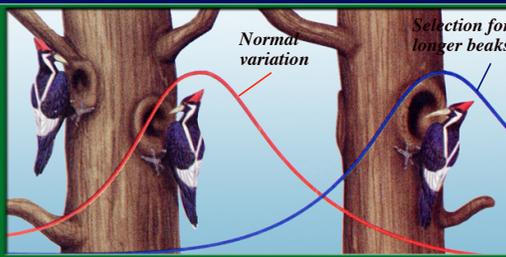
**Directional Selection**

- **One extreme variation** benefits
- **Increases at one end of graph**



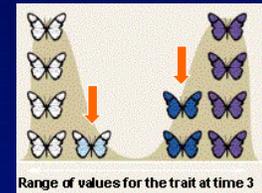
**Mechanisms of Evolution**

- **Directional selection** occurs when natural selection favors one of the extreme variations of a trait.

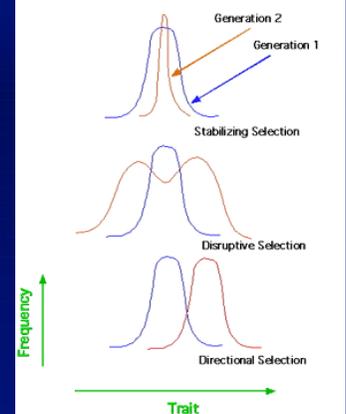
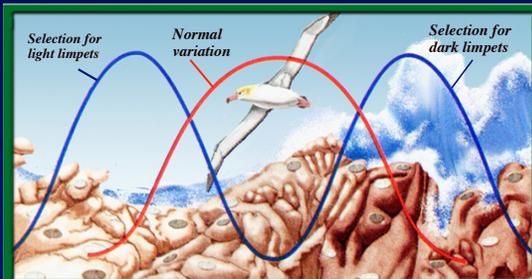


**Disruptive Selection**

- **Both extreme variations** benefit
- **Can result in formation of new species**
- **Increases at both ends of graph**
- **Decreases in middle of graph**



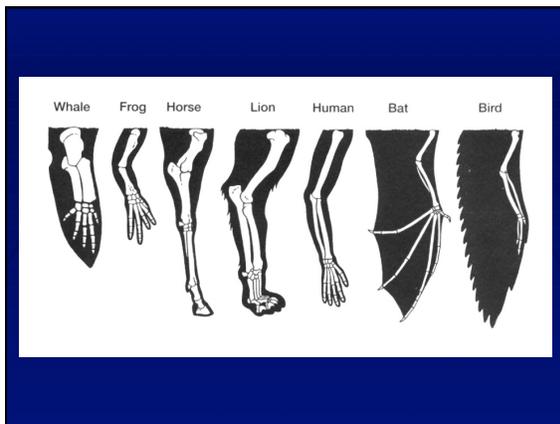
- In **disruptive selection**, individuals with either extreme of a trait's variation are selected for.



## Evidence of Evolution that Suggests that Organisms Evolved from a Common Ancestor

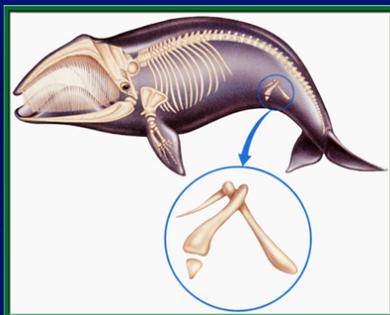
## Homologous structures

- CAN STUDY FOSSILS
- Body parts that have the same basic structure
- Whale flipper and arm
- Suggests organisms evolved from a common ancestor



## Vestigial structures

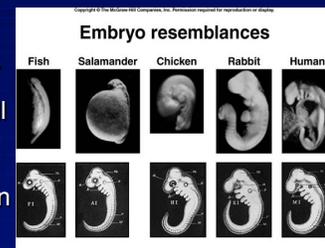
- Structures with no function
- Snakes – hip bones
- Humans – appendix
- Blind mole - eyes
- Suggests organisms evolved from a common ancestor



Whales have a pelvis (hip bone)

## Embryology

- Embryos of fish, birds, amphibians, reptiles and mammals have gill slits (not real gills) and tails
- Suggests evolution from common ancestor



## Biochemistry

- MOST RELIABLE EVIDENCE
- Study molecules of DNA, amino acid sequences, order of nitrogen bases, and enzymes (proteins) that make up living things
- Similar genetic codes and information suggest similar ancestors
- Higher percentage of same DNA = higher percentage of same amino acid sequences = closer in relation

According to the table, which of the following primates has the least amount of amino acid sequences in common with humans?

Which one(s) have the most?

Amino Acid Sequences in Primates				
Baboon	Chimp	Lemur	Gorilla	Human
ASN	SER	ALA	SER	SER
THR	THR	THR	THR	THR
THR	ALA	SER	ALA	ALA
GLY	GLY	GLY	GLY	GLY
ASP	ASP	GLU	ASP	ASP
GLU	GLU	LYS	GLU	GLU
VAL	VAL	VAL	VAL	VAL
ASP	GLU	GLU	GLU	GLU
ASP	ASP	ASP	ASP	ASP
SER	THR	SER	THR	THR
PRO	PRO	PRO	PRO	PRO
GLY	GLY	GLY	GLY	GLY
GLY	GLY	SER	GLY	GLY
ASN	ALA	HIS	ALA	ALA
ASN	ASN	ASN	ASN	ASN

## Rate of evolution – two theories

## Gradualism

- Slow process over long period of time
- Slow, gradual change of organisms
- Darwin's finches

## Punctuated equilibrium

- Species remain unchanged for millions of years
- Within short time certain species suddenly die off while new species suddenly appear
- Dinosaurs



## Patterns of Evolution

### Adaptive radiation

- One common ancestor
  - One species evolves into many different species
  - New species fit different habitats and/or niches
  - Darwin's finches
- Form of divergent evolution
  - Species become less alike as they adapt to environmental changes

### Darwin's Finches

Ancestor species



### Convergent evolution

- Distantly related organisms evolve similar traits due to similar environments
- Shark (fish) and dolphin (mammal) look similar and live in similar environments.

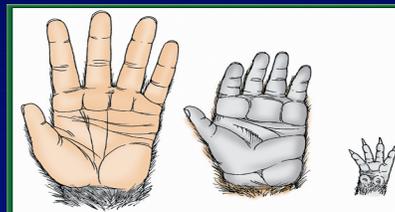


Dolphins and sharks are unrelated organisms that have evolved similar traits because they share similar environmental pressures.



### Characteristics of Primates

- Opposable thumb
  - Thumb can touch all other fingers



- Frontal, stereoscopic vision
  - Focus on one object with both eyes and see depth
- Flexible joints
- Ex: Humans, chimpanzees, lemurs



## Jane Goodall

- Studied and documented chimpanzee behavior

[http://www.ted.com/talks/jane\\_goodall\\_at\\_tedglobal\\_07/transcript?language=en](http://www.ted.com/talks/jane_goodall_at_tedglobal_07/transcript?language=en)

## Modern humans

- Bipedal
  - Walk upright on two legs
- Large, highly developed brain
- Jaw does not stick out from face
- Broad human pelvis allows humans to stand erect and supports internal organs.

Miller, K. R., & Levine, J. S. (2005). Chapter 16: Evolution of Populations. *Prentice Hall biology* (North Carolina ed., pp. 392- 415). Upper Saddle River, N.J.: Prentice Hall.

## Extra Studying

- While most of the information from these chapters is covered within this PowerPoint it may be beneficial for you to go and read/re-read the following chapters
- CK-12: UNIT 7 DO THIS!!!!!!!!!!!!!!!